MANITOBA

Environmental Management Division
Environmental Control Services

Environmental Control Programs

MG-1488

FILE: 2595.0
DATE: November 29, 1983

SOURCE TESTING FOR PARTICULATE EMISSIONS FROM THE INCINERATOR AT CARA OPERATIONS LTD., WINNIPEG, MANITOBA. 1983

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ABSTRACT

In August, 1983, a series of isokinetic source emission tests were conducted on the refuse incinerator stack at Cara Operations Limited. During normal operation the average particulate concentration, at stack CO_2 concentration, was 0.107 grams per dry standard cubic meter (g/dscm). When the stack CO_2 conditions are corrected to 12% CO_2, the average particulate concentration increases to 0.347 g/dscm. This is in excess of the Manitoba Regulation limiting particulate emissions from new incinerators to 0.23 g/dscm of dry flue gas when corrected to 12% CO_2.

INTRODUCTION

In order to determine compliance with Manitoba Regulation 334/74, the Environmental Management Division undertook to sample the refuse incinerator at Cara Operations Limited, Winnipeg International Airport. Although this company comes under federal jurisdiction, it is Federal Government policy for all establishments under their control to meet applicable provincial regulations. This policy is outlined in Section 3 of Environmental Protection Service Report 1-EC-78-5.

A multiple chamber incinerator is used to burn refuse from international commercial flights.

PROCESS DESCRIPTION

A Pyro Thermtec Model HU-150 multiple chamber incinerator was tested for particulate emissions. This type of incinerator promotes a two part combustion cycle. The primary and secondary chambers are heated by auxillary gas burners which are normally set to burn continuously for 4 and 4 1/4 hours respectively. When the secondary chamber reaches 149°C to 260°C (300°F to 500°F) the incinerator is charged with several bags of refuse, typically containing food, plastic, paper, metal cans and glass bottles. After the first and second hour, the incinerator is charged with several additional bags of refuse. Drying, ignition and combustion of the refuse then occurs in the primary chamber. Air intake to the primary chamber is carefully controlled so that the rate of combustion and therefore the temperature is controlled. This prevents turbulent high velocity gases from developing which could transport ash particles into the secondary chamber. Complete combustion of gasified and partially combusted volatile components is completed in the secondary (afterburner) chamber. Air is supplied in excess of stoichiometric requirements to ensure complete combustion.

The combustion products, mainly carbon dioxide and water vapor, are emitted via a 7.3 m (24 ft.) tall steel stack with a 7.6 cm (3 in.) thick ceramic liner. The stack has a continuous inside diameter of 42.4 cm (16.7 in.).

When the incinerator has cooled ash is removed from the primary chamber.

Figure 1 depicts the incinerator as installed at Cara Operations Limited.

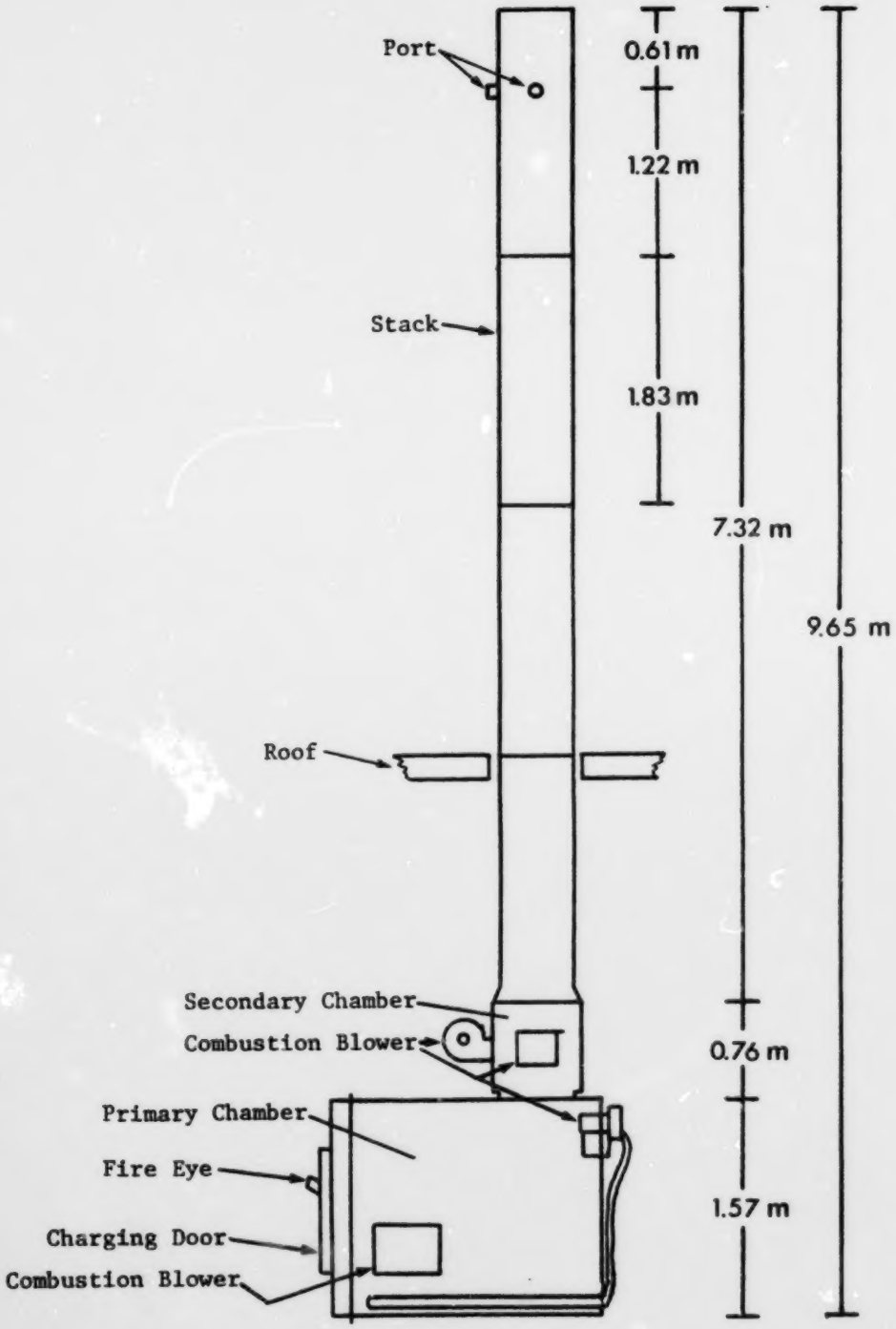


FIGURE 1. Pyro Thermtec Model HU-150 Incinerator as Installed at Cara Operations Ltd., Winnipeg International Airport

TEST PROCEDURES

All sampling was conducted from two 10 cm (4 in.) ports located at right angles to each other (south and east) 6.7 m (15.8 duct diameters) above the secondary chamber and 0.6 m (1.4 duct diameters) below the top of the stack. Four points were sampled along each traverse according to Environmental Protection Service (EPS) Method A Specifications. The sample points, located 2.8, 10.7, 31.8 and 39.6 cm from the stack wall, are depicted on a cross section of the stack in Figure 2. Sampling intervals were five minutes per point. Velocity profiles for tests 1, 2, 3 and 4 can be found in Appendix A.

Testing was conducted according to EPS Method E. The sample was drawn into a 12.70 mm (0.500 in.) nozzle, through a 1 metre stainless steel heated probe and into a miniature cyclone which removed particulate matter of greater than 10 μ diameter. The sample was then passed through a Whatman 934AH glass microfibre filter, supported by a porous fritted glass disc, which removed particulates of 0.3 μ diameter and greater. Both the cyclone and the filter were heated to prevent moisture from condensing at that point. The sample was then passed through four 500 ml Greenburgh-Smith impingers connected in series that were placed in an ice bath. All impingers had modified straight tips with the exception of the second which was the standard design. The first and second impingers were loaded with 100 ml of deionized water. The third

impinger was left empty while the fourth was loaded with 200 grams of indicating silica gel which removed remaining moisture from the gas sample. Figure 3 illustrates the particulate stack sampling train.

A Bendix Series 4500 Isokinetic Stack Sampler was used to extract the samples from the stack. Gas velocity in the stack was measured with an S type pitot tube and a Dwyer Model 2000-00AV Magnehelic Differential Pressure Gauge (range 0 to 0.25"H_2O), minor division 0.005"H_2O). Dry gas meter and pitot tube calibration data sheets are located in Appendix B. A Hays-Republic Model 621A Gas Analyzer was used to determine CO_2, O_2 and CO content of the stack gas. Stack temperature was measured by a K type thermocouple.

After sample recovery from the stack train, samples were submitted to the W. M. Ward Technical Services Laboratory for subsequent gravimetric analysis of particulates.

The sampling team consisted of Barry Cowan, Thomas Rae, Kevin Reeve, Art Schultz and Mark Steiman.

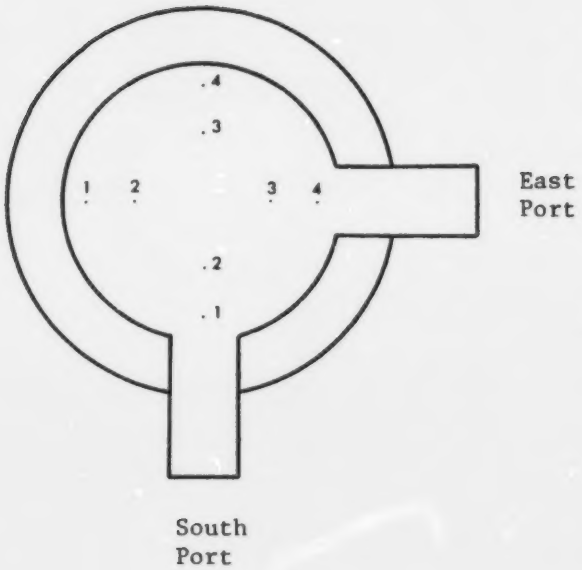
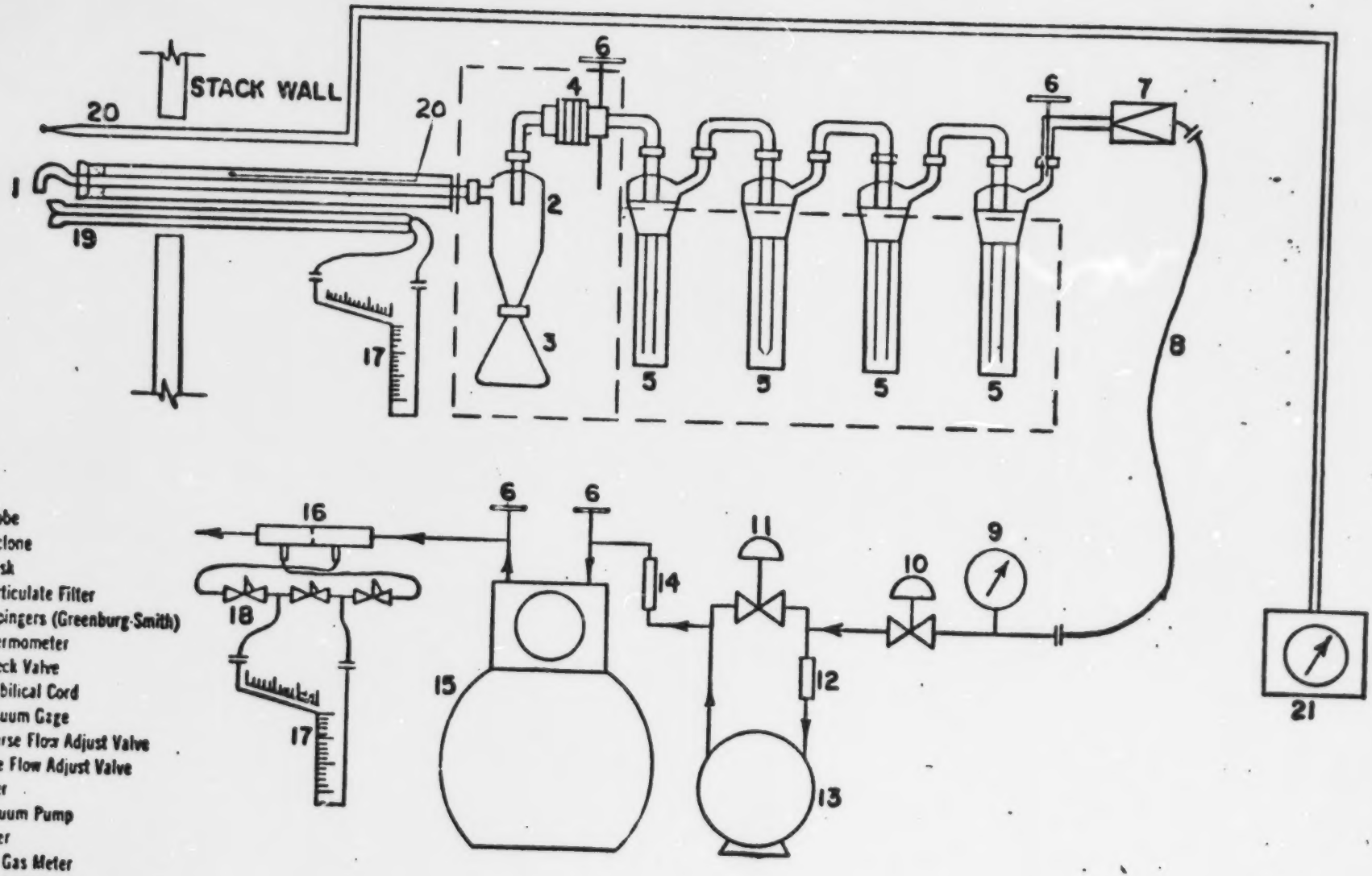


FIGURE 2. Stack cross section showing sample points.



1) Probe
2) Cyclone
3) Flask
4) Particulate Filter
5) Impingers (Greenburg-Smith)
6) Thermometer
7) Check Valve
8) Umbilical Cord
9) Vacuum Gage
10) Course Flow Adjust Valve
11) Fine Flow Adjust Valve
12) Oiler
13) Vacuum Pump
14) Filter
15) Dry Gas Meter
16) Orifice Tube
17) Incline Manometer
18) Solenoid Valves
19) Pitot
20) Thermocouple
21) Pyrometer

FIGURE 3: PARTICULATE STACK SAMPLING TRAIN

RESULTS

The incinerator was charged in the usual manner and operated normally during the four tests. Some of the more important sampling variables are summarized in Table 1. Refer to Appendix C for field data.

Source emission data are summarized in Table 2. The laboratory analytical reports are located in Appendix D.

TABLE 1: SUMMARY OF SAMPLING VARIABLES

TEST NUMBER	1	2	3	4
SAMPLING DATE	Aug. 4, 1983	Aug. 5, 1983	Aug. 11, 1983	Aug. 11, 1983
SAMPLING DURATION, min.	40	40	40	40
SAMPLING VOLUME @ METER CONDITIONS, m^3	0.591	0.569	0.599	0.578
SAMPLING VOLUME @ STANDARD CONDITIONS,*dscm	0.536	0.526	0.556	0.528
AVERAGE GAS METER TEMPERATURE, ^oC	43	38	38	43
ORIFICE PRESSURE DROP, mm H_2O	20.2	18.8	19.7	19.2
STACK STATIC PRESSURE, mm H_2O	+1.14	+1.14	+1.14	+1.14
AVERAGE STACK GAS TEMPERATURE, ^oC	603	554	586	603
AVERAGE STACK GAS VELOCITY, m/s	5.79	5.36	5.79	5.73
ISOKINETIC FACTOR, %	103.8	100.5	108.7	104.9

*Standard Conditions are 20^oC and 760 mm Hg

TABLE 2: SOURCE EMISSION SUMMARY

TEST NUMBER		1	2	3	4	AVERAGE
STACK GAS COMPOSITION DRY BASIS, % BY VOLUME	CO_2	6.0	5.2	3.2	3.2	-
	O_2	12.0	12.8	15.6	15.6	-
	CO	0.0	0.0	0.0	0.0	-
	N_2	82.0	82.0	81.2	81.2	-
STACK GAS MOISTURE % BY VOLUME		9.8	7.4	12.6	11.0	10.7
Ms**, g/g-mole		28.32	28.50	27.74	27.91	-
AVERAGE STACK GAS VOLUMETRIC FLOW RATE, dscm/h		863.9	875.5	857.8	847.8	861.3
CONCENTRATION OF PARTICULATE IN THE STACK GAS, g/dscm:	AT STACK CO_2	0.072	0.062	0.143	0.150	0.107
	at 12% CO_2	0.144	0.143	0.536	0.563	0.347
EMISSION RATE OF PARTICULATE, kg/h		0.06	0.05	0.12	0.13	0.09

** Molecular Weight of the Stack Gas on a Wet Basis

DISCUSSION

The higher than allowable particulate emission rate is due to the correction of stack CO_2 concentration to 12%. One reason for the low CO_2 concentrations experienced during the testing program may have been the method of operating the incinerator. Charging occurred several times per cycle rather than just once per cycle as the manufacturer's instructions indicate. This would have allowed an excess of air to enter the primary chamber which is designed to operate with a combustion air deficiency.

CONCLUSION

Results of the tests indicate an average particulate emission of 0.347 g/dscm when corrected to 12% CO_2 or 0.107 g/dscm at stack CO_2 conditions. When corrected to 12% CO_2 the particulate emission is in excess of the Manitoba Regulation 334/74 limit of 0.23 g/dscm.

This particulate emission rate is 0.09 kg/h.

BIBILOGRAPHY

1. "Air Pollution Guidelines Applicable to Incinerators at Federal Establishments", Report EPS 1-EC-78-5, Environmental Impact Control Directorate, Environment Canada, August, 1978.

2. "Standard Reference Methods for Source Testing: Measurement of Emissions of Particulates from Stationary Sources", Report 1-AP-74-1, Air Pollution Control Directorate, Environment Canada, February, 1974.

APPENDIX A: Velocity Profiles

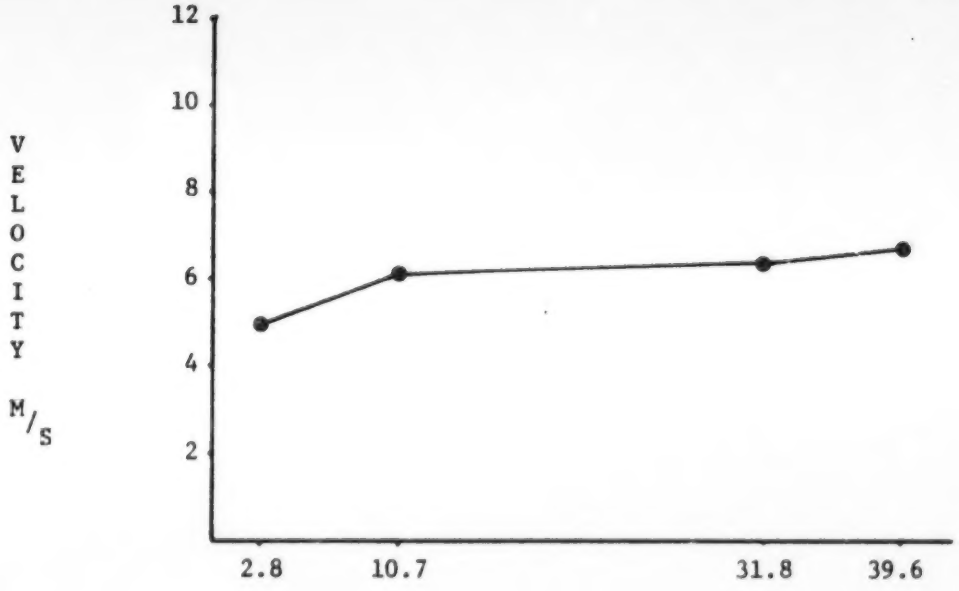
APPENDIX B: Equipment Calibration Data

APPENDIX C: Field Data Sheets

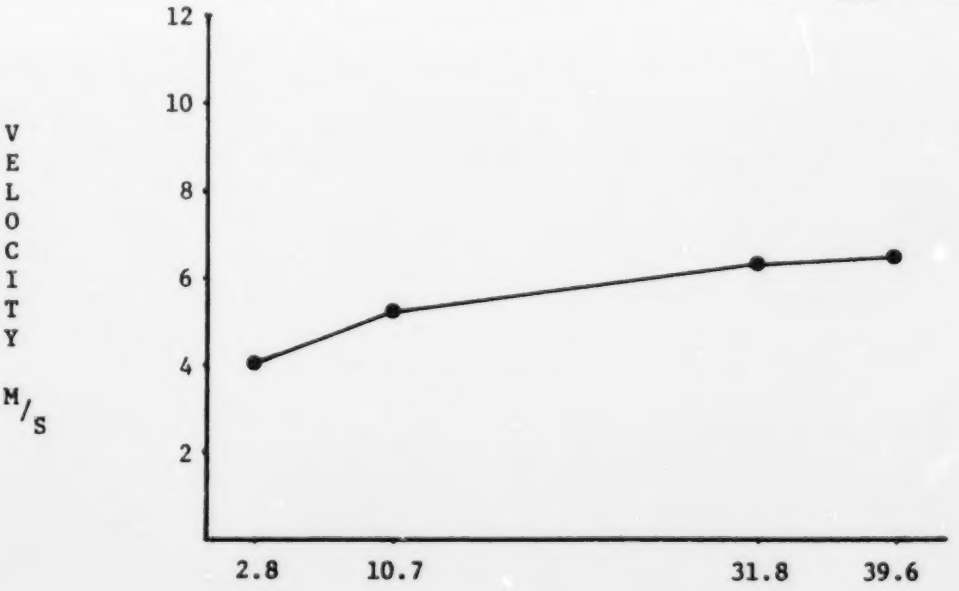
APPENDIX D: Analytical Report

APPENDIX A: VELOCITY PROFILES

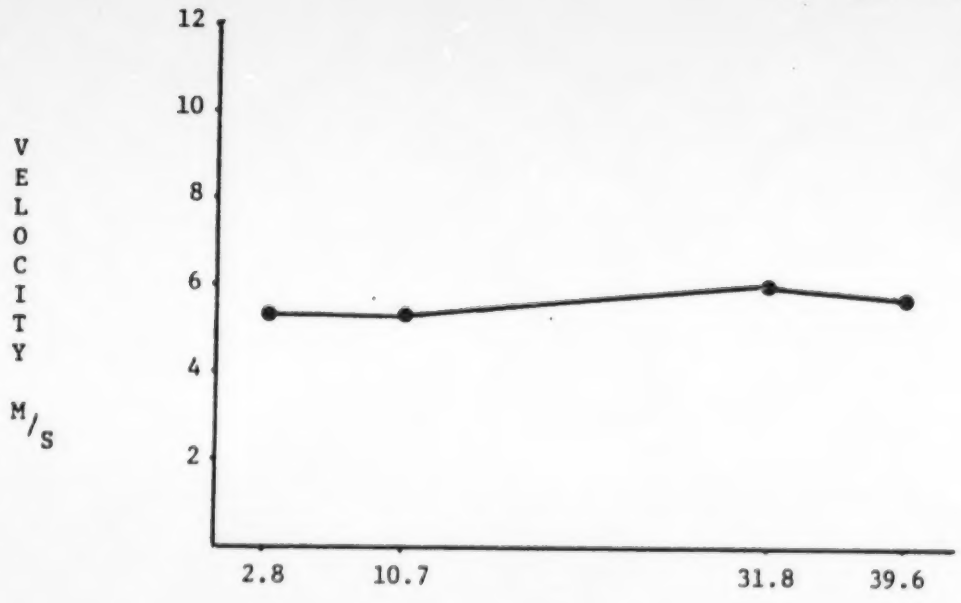
Graph 1 . Velocity Profile of Test 1 , East Port.
Wind S 16 to 26 km/hr



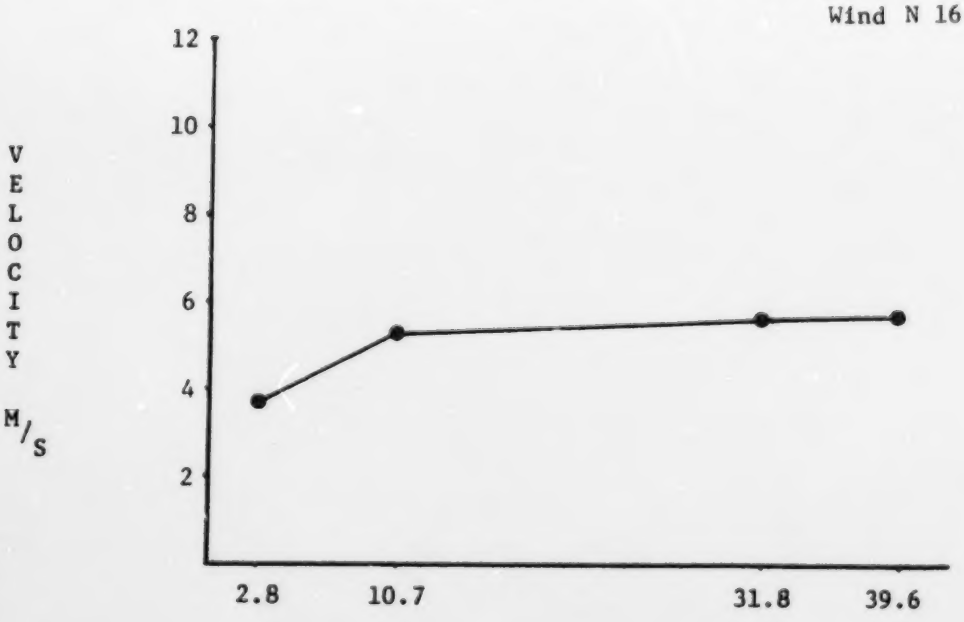
Graph 2 . Velocity Profile of Test 1 , South Port
Wind S 16 to 26 km/hr



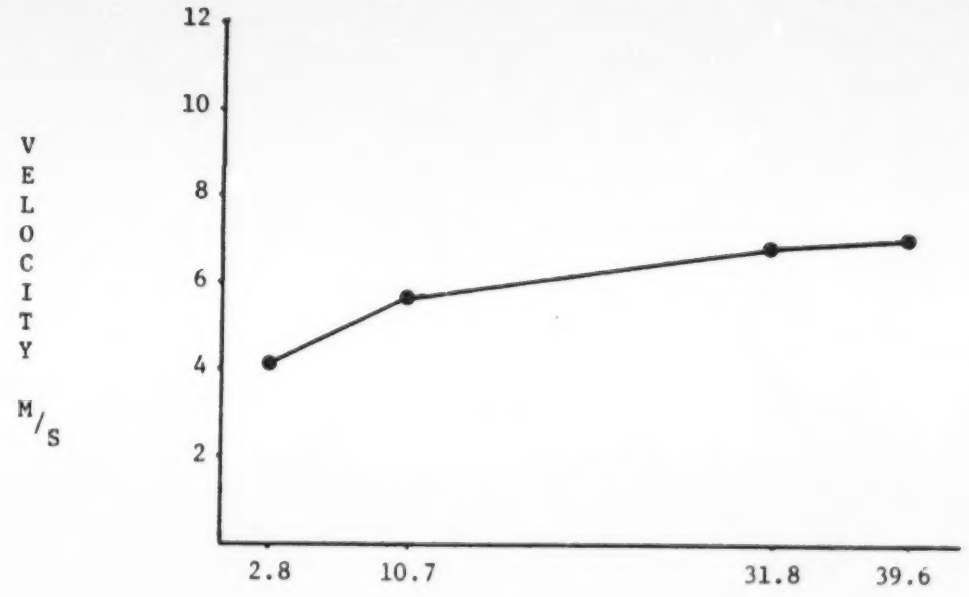
Graph 3 . Velocity Profile of Test 2 , East Port.
Wind N 16 to 26 km/hr



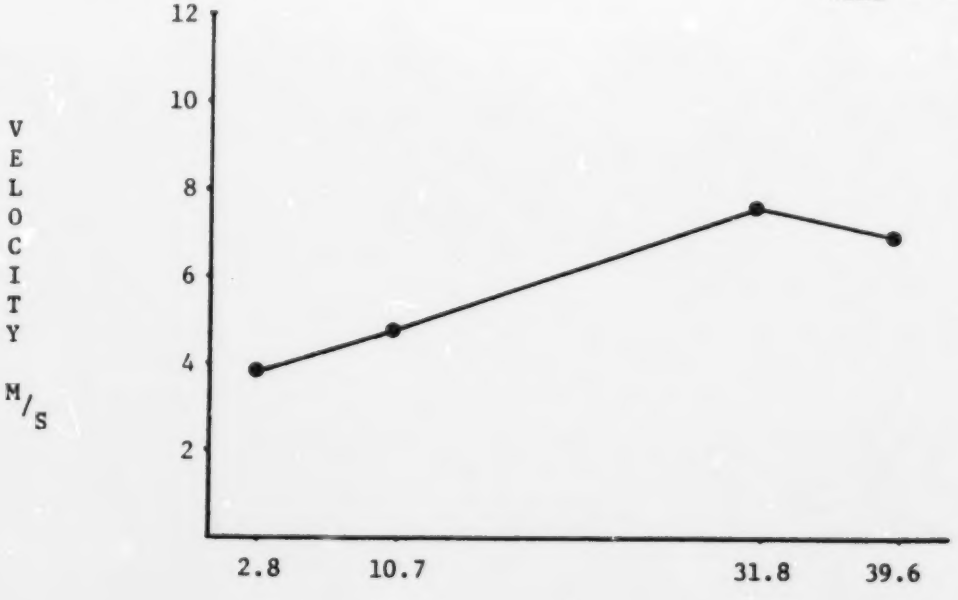
Graph 4 . Velocity Profile of Test 2 , South Port
Wind N 16 to 26 km/hr



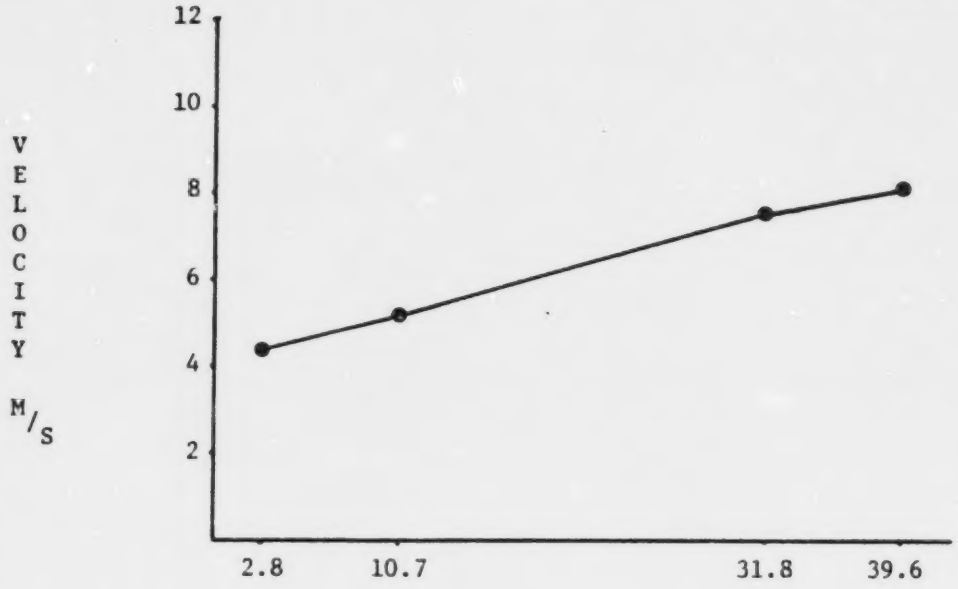
Graph 5 . Velocity Profile of Test 3 , East Port.
Wind S 16 km/hr



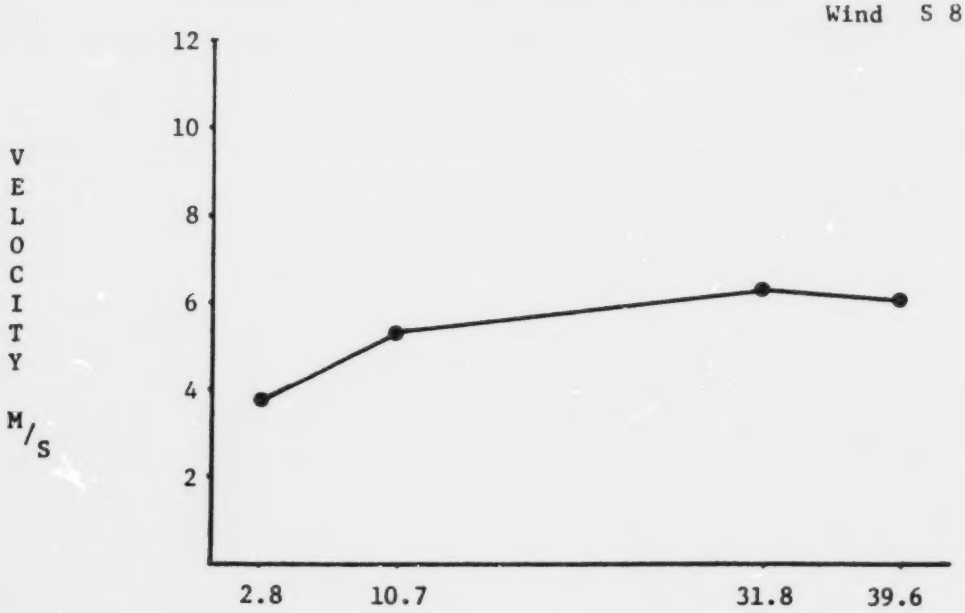
Graph 6 . Velocity Profile of Test 3 , South Port
Wind S 16 km/hr



Graph 7 . Velocity Profile of Test 4 , East Port.
Wind S 8 km/hr



Graph 8 . Velocity Profile of Test 4 , South Port
Wind S 8 km/hr



APPENDIX B: EQUIPMENT CALIBRATION DATA

DRY GAS METER & ORIFICE METER CALIBRATION SHEET

Dry Gas Meter S/N: DGM 711030

Average Atmospheric Pressure 29.29 in. Hg (744 mm Hg)

Calibrated by f P & M S

Calibrated with Large 115 ft - Test Meter

Ambient/Room Temperature 22.0°C - 21.8°C

Date 19 July 93

Anemometer Orifice (ΔH)	Wet-test Meter Volume (Vw)	Dry Gas Meter Reading: Initial	Dry Gas Meter Reading: Final	Dry Gas Meter Volume (Vr)	Wet-test Meter (Tw)	Dry Gas Meter (Ti)	Dry Gas Meter (To)	Time (t)		Wet-test Manometer (Δw)	Wet-test: Dry Gas Meter Ratio (γ)	Flowrate thru' Wet-test Meter @ Std. P. Meter (Qm)	Y	X
in. H2O	Ft.3	Ft.3	Ft.3	Ft.3	°F.	°C.	°F.	°C.	Min.:Sec.	Minutes	in. H2O	-	Ft.3/min.	-
0.491	5.0	243.820	253.873	5.053	70°	21.6	105	82	12:13.44	12.2240	0.15	1.004	0.4064	0.5599
0.768	5.0	255.998	261.777	5.079	70°	21.6	110	83	8:39.91	8.6652	0.24	1.003	0.5738	0.7814
1.95	5.0	264.022	269.134	5.106	71.0	21.7	113	85	6:14.13	6.2355	0.47	1.000	0.7985	1.1168
1.42	5.0	271.179	276.291	5.112	71.0	21.7	113	85	7:15.55	7.2592	0.35	1.000	0.6811	0.9536
2.79	5.0	279.342	284.446	5.104	71.0	21.7	114	86	5:08.00	5.1333	0.49	1.002	0.9795	1.3411
4.90	10.0	287.527	297.740	10.213	71.0	21.7	117	87	8:41.7	8.6945	0.66	1.001	1.1742	1.5983

Linear Regressions: Intercept (b) 0.0139

Slope (K) 0.7050

Coefficient of Determination (r^2) 0.9998

Average γ 1.002 ± 0.002

Δγ = 1.849

Comments:

Dry Gas Meter S/: Bendix 711C30

Calibrated with: Large Wet Test Meter

Average Atmospheric Pressure 29.05 in Hg // 738.0 mm Hg

Ambient/Room Temperature 21.5 °C

Calibrated by: D Fritz & K Reeve

Date 930903

Manometer Orifice (ΔH)	Wet-test Meter Volume (Vw)	Dry Gas Meter Reading: Initial	Dry Gas Meter Reading: Final	Dry Gas Meter Volume (Vd)	Wet-test Meter (Tw)	Dry Gas Meter (Ti)	Dry Gas Meter (To)	Time (t)	Wet-test Manometer (ΔH)	Wet-test: Dry Gas Meter Value (Y)	Flowrate thru' wet-test Meter (Qw)	Y / X
in. H_2O	ft^3	ft^3	ft^3	ft^3	°F	°F	°F	min:sec.	in. H_2O	-	ft^3/min	-
0.495	5.0	913.403	918.533	5.030	70.1	21.17	10.2	12 00.90	12 11.50	0.21	1.0043	0.4079	0.5624
1.01	5.0	920.555	925.932	5.078	70.1	21.17	10.9	10 07.63	10 12.32	0.29	1.0042	0.5070	0.5613
1.57	5.0	928.962	934.040	5.078	70.2	21.22	11.1	8 48.98	8 53.63	0.35	1.0039	0.7294	1.0039
2.02	5.0	936.275	941.394	5.119	70.3	21.28	11.5	8 03.77	8 08.28	0.41	1.0009	0.9224	1.1412
3.17	10.0	972.912	983.284	10.372	70.4	21.33	11.9	9 53.07	9 59.48	0.55	0.9962	1.0116	1.0715
4.07	10.0	966.38	976.693	10.307	70.5	21.39	11.4	8 34.91	8 39.18	0.65	0.9918	1.1946	1.1217

Linear Regression: Intercept (b) 0.0165

Slope (K) 0.7039

Coefficient of Determination (r^2) 0.9993

Average Y 1.0002 ± 0.0052

ΔH@ 1.9523

Comments:

Tab. No. 245 09/..

S-TYPE PITOT TUBE CALIBRATION

PROBE SIZE (ft)	3	CALIBRATION #	83-4
PROBE LINER	SS	DATE	83-03-15
PROBE MANUFACTURER	RAC	BAROMETRIC PRESSURE (Hg)	29.30
TIP SIZE (inches)	0.500	AMBIENT TEMP. (°C)	22.2
TIP TYPE	SS	OPERATOR	K.R., A.S.

STACK THERMOCOUPLE ☒ PRESENT ☐ ABSENT

HP 97 INPUT/OUTPUT

Temp	22.2	°C	4	3.17	Δ p (std)	7.30	Δ p (std)
Bar. Press	29.30	In. Hg		37.976613		57.629921	
Scale Factor	0.1			5.30	Δ p (s-pitot)	12.20	Δp(s-pitot)
				0.771444		0.771604	
				37.984571		57.641998	
	0.52	Δ p (std)	5	4.22	Δ p (std)	8.17	Δ p (std)
Tunnel Velocity	15.381131	ft/sec		43.817018		60.967393	
	0.90	Δ p (s-pitot)		7.05	Δ p (s-pitot)	13.70	Δp(s-pitot)
Cp, at this	0.758217	velocity		0.771746		0.770307	
Tunnel Velocity	15.384354	(using Cp)		43.826201		60.980170	
2	1.00	Δ p (std)	6	5.12	Δ p (std)		
	21.329791			48.263807			
	1.69	Δ p (s-pitot)		8.59	Δ p (s-pitot)	0.768522	Cp (ave)
	0.767308			0.770107		0.004288	Std. Dev.
	21.334261			48.273921		8	Deg. of Freedom
3	2.09	Δ p (std)		6.10	Δ p (std)		
	30.836121			52.680697		2.306	t .05
	3.54	Δ p (s-pitot)		10.25	Δ p (s-pitot)	0.765226	Low Cp
	0.766451			0.769513		0.768522	Mean Cp
	30.842583			52.691737		0.771818	High Cp

rev. 82-01

APPENDIX C: FIELD DATA SHEETS

FIELD DATA SHEET

Plant Cara Operations Ltd. Location Winnipeg International Airport

Stack Incinerator Test number 1 Date August 4, 1983

Ambient temperature (°F) 87 to 95 Barometric pressure (in. Hg) 29.15 Time 11:05 a.m. to 12:25 p.m.

Nozzle diameter (in.) 0.500 Probe length/type 3 ft./stainless steel Stack static pressure (in. H_2O) + 0.045

Probe temperature (°F) 196 (ave) Filter holder temperature (°F) 244 (ave) Leak check 0.010 CFM @ 10 " Hg Vacuum

Traverse point number	Clock time, start	Stack gas temperature, °F	Gas meter volume, cu. ft.	Velocity pressure, in. H_2O	Orifice pressure drop in. H_2O	Gas meter temperature, °F		Final impinger Temperature, °F	Pump vacuum in. H_2O	Isokinetic factor, %
						Inlet	Outlet			
East 1	0	1154	2.207	0.032	0.559	110	100	64	3	104.7
2	5	1187	2.598	0.046	0.804	117	100	62	4	103.0
3	10	1211	2.698	0.050	0.847	121	100	63	4	103.0
4	15	1209	2.844	0.055	0.931	125	102	64	5	103.0
South 1	20	870	2.198	0.025	0.537	111	108	70	4	105.6
2	25	1057	2.498	0.038	0.722	123	108	67	4	103.7
3	30	1103	2.882	0.052	0.957	123	108	68	5	103.6
4	35	1141	2.952	0.055	0.999	127	108	71	5	104.2
Average or total	40	1117	20.877	0.044	0.795	-	-	-	-	103.8

FIELD DATA SHEET

Plant Cara Operations Ltd. Location Winnipeg International Airport

Stack Incinerator Test number 2 Date August 5, 1983

Ambient temperature (°F) 83 Barometric pressure (in. Hg) 29.22 Time 10:55 a.m. to 11:55 a.m.

Nozzle diameter (in.) 0.500 Probe length/type 3 ft./stainless steel Stack static pressure (in. H_2O) + 0.045

Probe temperature (°F) 168 (ave) Filter holder temperature (°F) 217 (ave) Leak check 0.005 CFM @ 10 " Hg Vacuum

Traverse point number	Clock time, start	Stack gas temperature, °F	Gas meter volume, cu. ft.	Velocity pressure, in. H_2O	Orifice pressure drop in. H_2O	Gas meter temperature, °F		Final impinger Temperature, °F	Pump vacuum in. H_2O	Isokinetic factor, %
						Inlet	Outlet			
South 1	0	944	1.763	0.020	0.371	98	90	70	2	99.7
2	5	999	2.515	0.040	0.747	107	92	66	4	100.0
3	10	1060	2.620	0.045	0.812	111	92	66	5	100.1
4	15	1092	2.592	0.045	0.779	113	93	69	5	99.8
East 1	20	1005	2.533	0.040	0.736	102	95	68	4	101.3
2	25	1005	2.560	0.040	0.750	112	96	68	4	101.4
3	30	1035	2.840	0.050	0.918	116	96	69	5	101.6
4	35	1042	2.673	0.045	0.813	119	97	70	5	100.3
Average or total	40	1029	20.096	0.041	0.741	-	-	-	-	100.5

FIELD DATA SHEET

Plant Cara Operations Ltd. Location Winnipeg International Airport

Stack Incinerator Test number 3 Date August 11, 1983

Ambient temperature (°F) 78 to 84 Barometric pressure (in. Hg) 29.30 Time 9:43 a.m. to 10:40 a.m.

Nozzle diameter (in.) 0.500 Probe length/type 3 ft./stainless steel Stack static pressure (in. H_2O) + 0.045

Probe temperature (°F) 240 (ave) Filter holder temperature (°F) 244 (ave) Leak check 0.002 CFM @ 15" Hg Vacuum

Traverse point number	Clock time, start	Stack gas temperature, °F	Gas meter volume, cu. ft.	Velocity pressure, in. H_2O	Orifice pressure drop in. H_2O	Gas meter temperature, °F		Final impinger Temperature, °F	Pump vacuum in. H_2O	Isokinetic factor, %
						Inlet	Outlet			
East 1	0	665	2.504	0.030	0.710	100	89	54	4	106.6
2	5	1099	2.474	0.040	0.709	108	88	56	4	106.8
3	10	1259	2.728	0.054	0.866	112	89	57	5	106.0
4	15	1261	2.949	0.057	0.916	112	90	60	5	106.3
South 1	20	725	2.568	0.025	0.576	107	94	57	4	122.0
2	25	1056	2.207	0.030	0.554	113	94	59	4	107.6
3	30	1346	2.954	0.063	1.00	121	94	61	5	107.9
4	35	1283	2.774	0.055	0.877	120	94	64	5	106.6
Average or total	40	1087	21.158	0.044	0.776	-	-	-	-	108.7

FIELD DATA SHEET

Plant Cara Operations Location Winnipeg International Airport

Stack Incinerator Test number 4 Date August 11, 1983

Ambient temperature (°F) 84 Barometric pressure (in. Hg) 29.30 Time 11:13 a.m. to 12:08 p.m.

Nozzle diameter (in.) 0.500 Probe length/type 3 ft./stainless steel Stack static pressure (in. H_2O) + 0.045

Probe temperature (°F) 310 (ave) Filter holder temperature (°F) 284 (ave) Leak check 0.002CFM @ 15" Hg Vacuum

Traverse point number	Clock time, start	Stack gas temperature, °F	Gas meter volume, cu. ft.	Velocity pressure, in. H_2O	Orifice pressure drop in. H_2O	Gas meter temperature, °F		Final impinger Temperature, °F	Pump vacuum in. H_2O	Isokinetic factor, %
						Inlet	Outlet			
South 1	0	700	2.290	0.025	0.603	112	103	68	4	105.0
2	5	1085	2.358	0.035	0.636	117	101	68	4	104.6
3	10	116	2.825	0.050	0.904	124	101	70	5	105.3
4	15	1143	2.660	0.045	0.794	125	102	68	5	105.3
East 1	20	1021	2.085	0.025	0.481	110	102	58	4	107.5
2	25	1034	2.405	0.035	0.663	121	101	57	4	104.6
3	30	1421	2.815	0.060	0.899	123	101	57	5	104.8
4	35	1414	2.989	0.070	1.056	127	102	58	6	102.4
Average or total	40	1117	20.427	0.043	0.755	-	-	-	-	104.9

APPENDIX D: ANALYTICAL REPORT

W.M. WARD TECHNICAL SERVICES LABORATORY CHEMICAL ANALYSIS FORM II

SUBMITTER: KEVIN REEVE AR

LOCATION CARD OPERATIONS LTD RUN # 1

REPORT TO KEVIN REEVE

ER1

L – Less than
G – Greater than

SAMPLE – ID From: Y 83 Sequent 16195 To: Y 83 Sequent 16195

Date Sampled: Y 83 M 08 D 04

Date Received: Y 83 M 08 D 17

Sample Number	Identification or Comments	Parameter	L/G	Value	Units	Date Analyzed
16953	BLANK # 1	TSP		.0161	g	83.09.19
16954	BLANK # 2	TSP		.0117	g	83.09.16
16955	FILTER 367	TSP		.0227	g	83.09.17

Date 83-09-23

Checked By

WM. WARD TECHNICAL SERVICES LABORATORY CHEMICAL ANALYSIS FORM II

SUBMITTER: KEVIN REEVE — A575

LOCATION: CMA OPERATIONS STD RUN #2

REPORT TO: KEVIN REEVE — ER-1

From SAMPLE – ID: Y 83 Sequent 16986 — To: Y 83 Sequent 16988

L – Less than
G – Greater than

Date Sampled: Y 83 M 08 D 03

Date Received: Y 83 M 08 D 15

Sample Number	Identification or Comments	Parameter	L/G	Value	Units	Date Analyzed
16986	BOTTLE #1	TSP		.0217	g	8-24
16987	BOTTLE #2	TSP		.1653	g	8-24
16988	FILTER # 368	TSP		.0107	g	8-24

Date 8-30-83

Owner Signature

W.M. WARD TECHNICAL SERVICES LABORATORY CHEMICAL ANALYSIS FORM II

SUBMITTER KEVIN REAVE HS-S
LOCATION CORA OPERATIONS LTD #3
REPORT TO KEVIN REEVE
EA-1

L – Less than
G – Greater than

SAMPLE - ID From: Y 83 Sequence 16949 To: Y 83 Sequence 16991

Date Sampled: Y 83 M 06 D 11

Date Received: Y 83 M 08 D 15

Sample Number	Identification or Comments	Parameter	L/G	Value	Units	Date Analyzed
16959	BOTTLE #1	TSP		1648.0	g	83.08.26
16990	BOTTLE #2	TSP		1099.1	g	83.08.26
16991	LINER # 269	TSP		163.15	g	83.08.17

83.08.26

W.M. WARD TECHNICAL SERVICES LABORATORY CHEMICAL ANALYSIS FORM II

SUBMITTER: KEVIN REEVE 1575
LOCATION: CARA OPERATIONS LTD RUN 4
REPORT TO: KEVIN REEVE
ED-1

SAMPLE – ID
From: Y 83 Sequence 16992
To: Y 83 Sequence 16994

L – Less than
G – Greater than

Date Sampled: Y 83 M 5 D 17
Date Received: Y 83 M 5 D 23

Sample Number	Identification or Comments	Parameter	L/G	Value	Units	Date Analyzed
16992	BOTTLE #1	TSP		.6.4.1.3	g	83.6.6
16993	BOTTLE #2	TSP		.6.1.3.8	g	83.6.26
16994	FILTER #370	TSP		.6.3.7.7	g	83.6.17

Date 83.7.26